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Plasma and Ion Assistance in Physical Vapor Deposition: A Historical Perspective

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A review is presented on plasma and ion assistance for physical vapor deposition processes. Emphasis is put on the significant milestones and accomplishments using plasmas for the deposition technologies. For obvious reasons, no claim is made to be comprehensive or complete.

Deposition of films using plasmas or plasma-assist can be traced back surprisingly far, namely to the 18th century for arcs and to the 19th century for sputtering. Major steps forward in terms of understanding were done at the beginning of the 20th century after the electron was discovered and the first quantum models of the atom evolved. Langmuir introduced the term "plasma" in 1928, initiating a branch of science on its own. With the space program in the Soviet Union and the United States in the 1950s and 60s, several "plasmatrons" and "plasma thrusters" where developed, which later became key components for plasma and ion assisted deposition (for example, recall end hall and closed drift sources). Gridded sources, such as the Kaufman source, became commonplace. In another branch of developments, flows of condensable plasmas were used for coatings such as plasmas made by pulsed laser ablation and cathodic arcs ("self-assisted deposition"). The role of energetic assistance for the formation of desirable micro and nanostructures, was recognized, accomplished either by a separate source of ions or plasma, or by the energetics of the condensing plasma itself. A whole family of processes evolved, among them ion-beam-assisted deposition (IBAD) and plasma immersion processing.

Plasma and ion assisted processes are indispensable in today's coating world. Modeling and simulation have helped to make plasma and ions reasonably well understood tools that are broadly used, yet -- due to the complex, often non-linear and non-equilibrium nature of plasma and surface interactions, there is still room for the experienced ion and plasma "sourcerer."

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